EPA Level of Effort (LOE) for Assessment and Estimations of Upland Soils - Upper Columbia River Basin

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Developed by: EPA Technical Team

1. Goals

This document outlines the expected Level of Effort (LOE), associated Data Quality Objectives (DQOs), and guidelines for performing an Upper Columbia River (UCR) upland background soil assessment using existing data. The goal is to estimate concentrations, or range of concentrations for contaminants of interest (COIs), contaminants of potential concern (COPCs), and useful indicator elements that represent area or potentially natural background upland conditions associated with northeastern Washington State and the UCR Site. Deriving estimates of upland surface and near-surface soils representative of background conditions for known metal COIs is a critical element of the remedial investigation/feasibility study (RI/FS), Baseline Ecological Risk Assessment (BERA) and Human Health Risk Assessment (HHRA).

This LOE process describes the U.S. Environmental Protection Agency's (U.S. EPA's) expectations for completing an initial analysis of upland background metal concentrations data. The approach will likely rely on existing data and studies. U.S. EPA believes existing data and studies are likely sufficient to estimate soil background levels in the UCR basin in Washington State.

2. General Approach

The recently completed RI residential and upland soil sampling programs documented elevated metals in residential and non-residential areas of the UCR Site. Smelter releases have been identified as the primary source for observed upland soil metal pollution (SRC, 2015). Estimating upland background requires avoiding or minimizing areas with known or anticipated anthropogenic impacts. If potential outliers are identified or suspected during the analysis, then screening criteria should be applied to existing data sets, based on UCR Site knowledge, sample location, to estimate unbiased upland background concentrations.

The steps for screening, selection and application of soil and tributary data sets to estimate background metals concentrations under this LOE will consider and refine data use along several categories. The assessment process described in this LOE identifies existing studies, data selection guidelines, and summarizes current UCR Site knowledge. Applicable data set evaluations are included as Attachment A.

3. Data Quality Objectives, Steps One through Three

The Data Quality Objectives (DQOs) were developed using U.S. EPA's 2006 guidance document, *Guidance on Systematic Planning Using the Data Quality Objectives* (U.S. EPA, 2006a). Steps one through three of the DQO process are described below.

Step 1: State the Problem

The UCR site is located in the north central portion of Washington State and includes approximately 150 river miles of the Columbia River, extending from the United States-Canada border south and west to the Grand Coulee Dam. An RI/FS is currently underway in response to concerns regarding discharges of hazardous substances into the Columbia River and surrounding upland areas, including but not limited to discharges of granulated slag, liquid effluents, emissions, and accidental spills and "upsets" from smelting processes and facility operations by Teck at the Trail facility located in Trail, British Columbia.

Emissions from the smelting facility in Trail have included metal-enriched particulates which were deposited at varying distances from the smelter and became incorporated into surface soil and tributary drainages. As described in the RI/FS work plan (U.S. EPA, 2008), the primary objectives of the RI/FS are to investigate the nature and extent of contamination at the site, to support baseline risk assessments for human health and the environment, and to develop and evaluate potential remedial alternatives at the Site (U.S. EPA, 2008, 2009; Parametrix et al., 2011). Comparing metal concentrations in contaminated soils and upland sediments to background metal concentration estimates is an essential component of the RI/FS (U.S. EPA, 2002a).

The UCR RI/FS has not finalized estimates of the background concentrations of metals in soil, though others have. Background soil concentrations of COIs (HHRA)/ COPCs (BERA) derived through the DQO process will be used for both the HHRA and BERA for the UCR site.

U.S. EPA guidance (U.S. EPA, 2002a, b) defines two types of background: ***naturally occurring background*** and ***anthropogenic background***.[1] Similarly, the State of Washington Administrative Code (WAC, 2001) defines two types of background that are used by Washington's Department of Ecology (Ecology) for assessing background concentrations in soil[2]: ***natural background*** and ***area background.***[3] While the state of Washington's definition of "natural background" includes global anthropogenic sources of contaminants, Washington's "area background" is more consistent with U.S. EPA's "anthropogenic background" (i.e., both are intended to incorporate local geogenic and anthropogenic contributions of a contaminant that are unrelated to the dominant primary source of contamination in question). In this LOE the Ecology definition of natural and area background is used, with the recognition that fully avoiding historical smelter emissions and global lead emissions from leaded gasoline may not be practical or necessary.

The HHRA Work Plan (Section 4) describes a "Total Risk" approach to quantifying risks (U.S. EPA 2009). In the total risk approach, background data are not used to "screen out" chemicals or exposure pathways; risks are generally evaluated for all metals even if they are attributable to natural or other non-

[1] "Naturally occurring" refers to the concentrations of substances present in the environment in forms that have not been influenced by human activity. "Anthropogenic" concentrations of substances are natural and human-made substances present in the environment as a result of human activities (not specifically related to the site in question) (U.S. EPA, 2002a,b).

[2] Regional background is a third type of background that is sometimes used to define background concentrations in sediment (ECY, 2015a).

[3] "Natural background" refers to the concentration of a hazardous substance consistently present in the environment that has not been influenced by localized human activities. Natural background includes both geogenic sources and anthropogenic contribution from global distributions of hazardous substances. "Area background" refers to the concentrations of hazardous substances that are consistently present in the environment in the vicinity of a site which are the result of human activities unrelated to releases from that site. (ECY, 2007).

site related sources. Risk is calculated for all chemicals above a level of potential concern. Background data can support risk communication and risk management (see Figure 1).

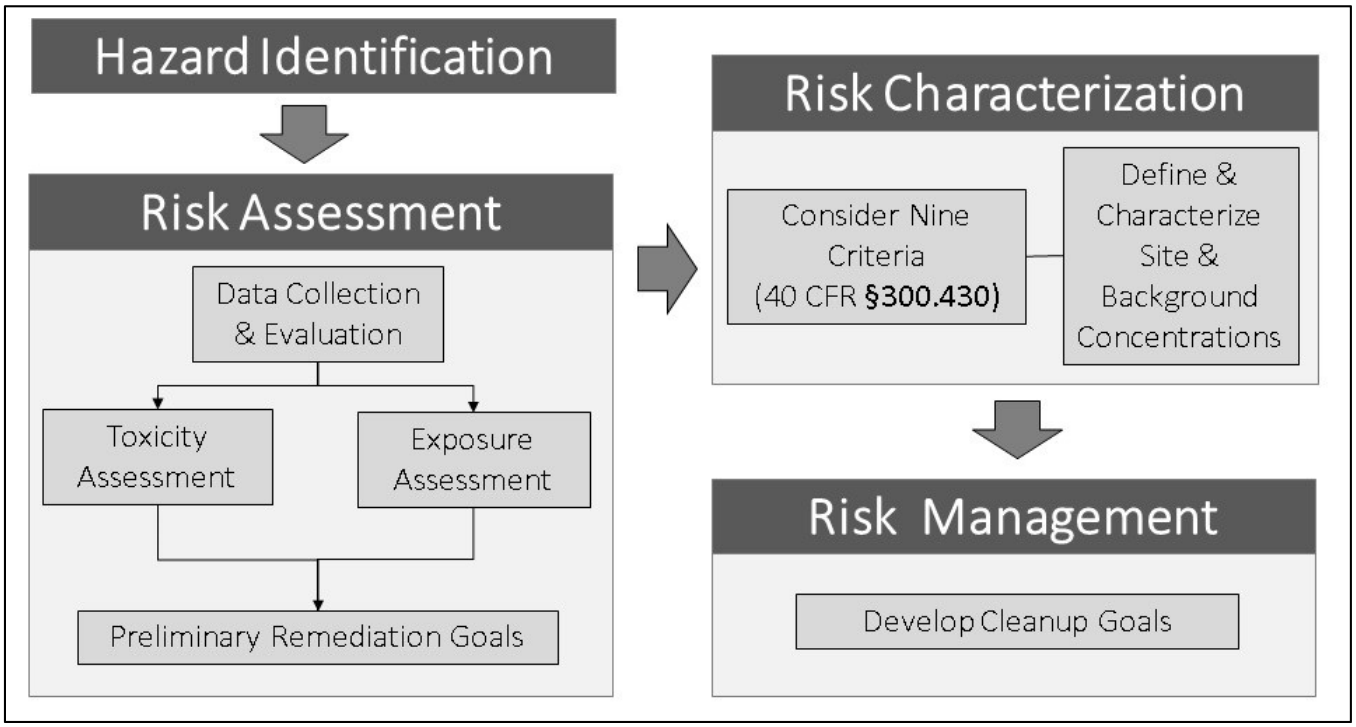

Figure 1. Overview of U.S. EPA's site assessment and risk management process that incorporates site and background concentrations of chemicals of concern into the site decision.

Recognizing the nature and contribution of background concentrations for the assessment of total risk associated with COIs/COPCs, as well as characterization of the Site, is important for refining risk management decisions (e.g., cleanup goals) at a site (U.S. EPA, 2002a):

> *"In RAGS-A, U.S. EPA cautioned that eliminating COPCs based on background (either because concentrations are below background levels or attributable to background sources) could result in the loss of important risk information for those potentially exposed, even though cleanup may or may not eliminate a source of risks caused by background levels. In light of more recent guidance for risk-based screening (U.S. EPA, 1996; U.S. EPA, 2000) and risk characterization (U.S. EPA, 1995), this policy recommends a baseline risk assessment approach that retains constituents that exceed risk-based screening concentrations. This approach involves addressing site-specific background issues at the end of the risk assessment, in the risk characterization"* (U.S. EPA 2002a).

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), does not typically set cleanup levels below natural background levels due to technical practicability, cost, and the potential for recontamination of remediated areas by surrounding background (U.S. EPA, 2002a). CERCLA response actions or cleanups typically include the consideration of the nine criteria provided in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 1990). According to the NCP (1990), cleanup levels selected for sites include consideration of site-specific information and

circumstances, and include the protection of human health and the environment, regulatory compliance, both short- and long-term effectiveness, cost considerations, and acceptance (both local and state).

Estimated background concentration values will be used to:

1. Distinguish site-related risks from background risks;
2. Identify risk-based screening values in the HHRA and the BERA that may be below natural background concentrations;
3. Inform the feasibility study (e.g., to avoid cleanup actions that are based on concentrations below background levels);
4. Facilitate risk communication by providing context for the site-related contamination and risk (e.g., describing the risk related to the non-site related anthropogenic and natural concentrations of lead, arsenic and other metals); and
5. Identify potential data gaps.

More than one background value (e.g., mean, upper confidence limit on a mean, upper percentile, or upper tolerance limit on a percentile) may be needed depending upon the specific use.

Step 2: Identify the Goal of the Study

Estimate a concentration, or range of estimated concentrations, for each COI/COPC, as well as useful indicator elements, that represents background upland concentrations appropriate for the UCR Site for use in the HHRA and BERA. The following questions are designed to achieve these outcomes:

Principal Study Question:

- What are the background concentrations of aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, fluoride, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silicon, silver, sodium, sulfur, tin, thallium, uranium, vanadium, and zinc in soil?[4]

Alternative Outcomes:

- Action: Estimation of background concentrations:
  - Outcome 1: There are sufficient data to estimate natural background concentration estimates with the required precision; additional data are not required at this time.
  - Outcome 2: There are not sufficient data to estimate natural background concentrations to achieve the required precision; additional data are needed.

Estimation Statement:

For COI/COPCs and elements of interest the minimum, maximum, mean, median, geometric mean, and upper percentiles of the distribution will be estimated at a minimum, along with upper

[4] The HHRA Work Plan (U.S. EPA 2009) also lists the following "other metals and metalloids" as COIs: bismuth, cerium, cesium, dysprosium, erbium, europium, gadolinium, gallium, germanium, gold, holmium, indium, lanthanum, lithium, lutetium, neodymium, niobium, praseodymium, rubidium, samarium, scandium, strontium, tantalum, tellurium, thorium, thulium, titanium, tungsten, ytterbium, yttrium, and zirconium.

confidence limits where appropriate. The estimates may consider possible regional differences in area or natural background concentrations due to differences in soil types and local mineralized sources. Anthropogenic influences will be addressed with site knowledge and statistical analyses, including ProUCL (Singh and Singh 2013) and Scout (Singh et al. 2008).

Step 3: Identify Information Inputs

Studies will be reviewed to determine if sufficient data of adequate quality meet the performance criteria that will be established for determining background in Step 6 of this DQO process. In general, soil and tributary surface sediment concentration data are needed in areas that represent near-natural or area background concentrations in the vicinity of the UCR basin. While several of the studies evaluated in preparation of this DQO process contain soil data, several contain sediment data as well (Attachment A). Sediment and soil may be influenced by different geogenic and/or anthropogenic sources that may not directly represent the natural background at a specific sample location; however, upland tributary sediment and soil data are judged as representative of elemental background surface abundances on a regional site scale if they are similar enough to soil collected in terms of particle size and concentration, and will be incorporated into this background assessment.

The EPA and participating parties have summarized key, primary upland data sets and reported studies to define eligible and data-specific-appropriate samples and results to be applied in this assessment.

The following studies were identified as potential sources of data and are summarized in Table 1 and Attachment A:

1. Church UCR background and NURE assessment, and Midnite Mine sediment background evaluation (Church, 2010a and Church et al. 2008);
2. NURE database summary (Church, 2010b);
3. Department of Ecology natural soil background concentrations (ECY, 1994);
4. Department of Ecology border soil study (Hart Crowser, 2013a)
5. Van Stone Mine background study (Hart Crowser, 2013b);
6. CCT background assessment tech memo (MESL 2014) -Tributary data applied by MESL includes Phase 1 UCR sediment sampling (U.S. EPA, 2006b);
7. Port of entry study (Shannon Wilson 2011);
8. USGS geochemical and mineralogical data for soils (Smith et al., 2013);
9. Preliminary Assessments and Site Investigations (PA/SI) report for Pend Oreille County (U.S. EPA, 2002c);
10. PA/SI report for Stevens County (U.S. EPA, 2002d);
11. Expanded Site Inspection report for the UCR (U.S. EPA, 2003a);
12. Upper Columbia River Soil Study Data Summary Report (Windward, 2015), and;
13. Wells lichen and soil dissertation (Wells, 2015);

Three of these studies were either conducted for or by Ecology. Ecology published its soil background study in 1994 (ECY, 1994). Hart Crowser (2013a) conducted a soil sampling study in upland areas of the UCR as an initial assessment of surface and shallow subsurface conditions in the UCR valley. As part of the RI at the Van Stone Mine and Mill, Ecology performed a site-specific soil and sediment background evaluation (Hart Crowser, 2013b).

From 1976 to 1981, the U.S. Department of Energy (DOE) conducted the NURE-Hydrogeochemical Stream-Sediment Reconnaissance (NURE-HSSR) program throughout the U.S. This sampling and analysis effort, which was a collaboration with DOE and four national laboratories, primarily sampled surface sediments; a large number of samples were collected from dry (intermittent) streambeds and perennial (wet) upland streams (Ciminesi, 1979 as cited in Church, 2010a). The NURE data are currently maintained by the USGS. More recently, the USGS National Geochemical Survey was conducted in concert with state agencies and private entities to produce a body of geochemical data for the United States. For Washington, the data in the National Geochemical Survey consists of selected NURE data reevaluated in 2000, and data collected by the Washington State Department of Natural Resources (DNR) Division of Geology & Earth Resources from 2001 to 2006. Finally, in 2007, the USGS initiated a geochemical and mineralogical survey of soils in the U.S. as part of the North American Soil Geochemical Landscapes Project (Smith et al., 2013). Sampling was completed in 2010; the resulting database is described by USGS as a baseline for soil geochemistry and mineralogy against which future changes may be compared. The USGS data can be found in online accessible databases (Smith 2006, USGS 2015).

Various U.S. EPA-related documents and appropriate data have been evaluated. EPA PA/SI, ESI, and RI UCR studies contain applicable data discussed in Attachment A (U.S. EPA 2002c, 2002d, 2003a, 2006b, and Windward 2015). Also potentially useful, Attachment 1-4 of the U.S. EPA Ecological Soil Screening Levels guidance document (U.S. EPA, 2003b) cited various reports that should be evaluated. The SSURGO soils database (USDA NRCS, 2015) may be useful for evaluating whether the natural background concentration varies significantly among soil types for some metals in northeastern Washington State.

Other applicable studies or assessments and associated data meeting criteria from other bodies of work have been evaluated and selected for this background estimation (see list above and Attachment A).

Criteria and Application

As demonstrated in Attachment A, the data must include: sample coordinates (or reasonably approximate locations), sample depth, must be located near the UCR, and should generally be located outside of the following exclusion areas:

- The pre dam era 100-year floodplain of the UCR (may include slag and effluent wastes) and the maximum high water elevation of Lake Roosevelt (may include slag or effluent wastes);
- The historic $S0_2$ smelter injury footprint zone of the upper Columbia River Valley as originally defined by Scheffer and Hedgcock 1955, or similar smelter impact references (area of greatest potential emissions impacts), depending on sample depth and observed concentrations. Aerial emission wastes from the Trail smelter and to a lesser degree the Le Roi Smelter along the river valley may be deposited on or washed into down-gradient upland soils, lakes, and wetlands, particularly within the SO_2 impact area. Several emission COIs exhibit highest concentrations within this area ; and,
- Areas that have been disturbed by human activity consistent with the 2014 RI Upland Soil Study (Windward, 2015), particularly areas near well-established roadways and railways [represented by a 50 m buffer from the center line of these features in either direction]) and areas proximal to mine and mill workings in the watersheds [represented by 500 m buffers]. Natural forces (e.g.,

landslides) should also be considered if likely exposing lithic samples not representative of surface or near-surface materials.

Data that meet the above criteria will be evaluated to estimate background levels and to identify potential outliers:

- Sampling depth; for example, data from locations within the area of SO_2 damage to trees (Scheffer and Hedgcock, 1955) and lake sediment data must be located at sufficient depth in the soil profile to represent minimal anthropogenic influences.
- Type of sample (e.g., composite versus discrete sample);
- Soil type (e.g., based on SSURGO soil database [USDA NRCS, 2015]);
- Particle sizes (the study will prefer data for <2mm.
- Particles from the <150µm size fractions are also desirable for relevance to exposure to people from inadvertent ingestion;
- Digestion/analytical methods considerations; and,
- Detection limits and the number/frequency of results that are reported as below a detection limit.

These criteria and factors as applied to completed studies are summarized in Attachment A. Additional data sets would undergo a similar review and approval by EPA. The intention of these DQOs is to guide estimating background soil concentrations for COPCs and COIs. For example, previous studies have successfully evaluated individual watersheds within the greater upper UCR basin in Washington State to evaluate geographic and geologic variability. This LOE seeks analyses that will include evaluating the utility of these types of subcategories within the greater UCR basin in Washington State. For some data sets, comparisons between different grain sized samples may be useful. In addition, the data should be evaluated to determine if they reflect anthropogenic (not site-related) influences (based on concentration, location and data documentation) or local, mineralized areas.

4. Conclusion

Preliminary Remediation Goals will consider the higher of either background estimations and the lowest EcoSSL (http://www.epa.gov/ecotox/ecossl/) or human health RBC (SRC 2014). Proposed methods and data sets will be presented for EPA review prior to full analysis and interpretation. The methods and results of this assessment will be presented for EPA review and comment in a draft assessment report and electronic deliverables.

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